ABNORMALITIES IN NICOTIANA[1]

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(WITH TEN FIGURES)

Synanthic blossoms

Synanthy, or coalescence of blossoms, was noted in a species of tobacco, the seed of which was obtained from South America (S.P.I. no. 33708). This collection of seed gave red, purple, and white-flowered plants. In leaf characters the plants appeared fairly uniform. Although the seed was labeled *N. longiflora*, it may be said that these plants bear no resemblance to that species. They resemble *N. alata* Link and Otto (*N. affinis* Moore) and undoubtedly belong to this species. DEVRIES[2] mentions the occurrence of fasciation in *N. alata*.

The plant which furnished the abnormal blossoms produced beautiful white, exceptionally large blossoms. Three of the more striking abnormalities exhibited different degrees of double-blossom structure. In one instance three blossoms were concerned in the coalescence. These abnormal blossoms were distinguished by the following characteristics (figs. 1, 2, 3):

ABNORMALITY NO. 1.—A union of two blossoms which affected only the corolla tube and calyx. Although the corolla tubes were joined throughout their length, they did not communicate by an opening at any point. In all respects each blossom retained its individuality, possessing the normal number of 5 petals and 5 stamens, one pistil and ovary. In this double-blossom structure the corolla tubes merely adhered, so to speak, along their entire length. The calyx, however, showed a more intimate union, and appeared as one structure with 7 sepals.

ABNORMALITY NO. 2.—In this instance there is but one corolla tube inclosing the stamens, pistils, and the two ovaries. This

[1] Published by permission of the Secretary of Agriculture.

[2] DEVRIES, HUGO, Over de erfelijkheid der Fasciatiën. Bot. Jaarboek (dodoreea) VII. Aug. 1894 (see pp. 94 and 115).

corolla tube, however, is but little larger than the double-tube structure of blossom no. 1. Seven well developed petals were present and 8 filaments bearing anther sacs. One filament was a

FIG. 1.—Side views of abnormal blossoms: *1*, corolla tubes united but not communicating by openings; pistils and ovaries separate in each tube; *2*, single corolla tube inclosing both ovaries and stigmas; *3*, single corolla tube inclosing fasciated pistils and ovaries; ovary walls distinct within; *4*, normal blossom.—T. 1560.

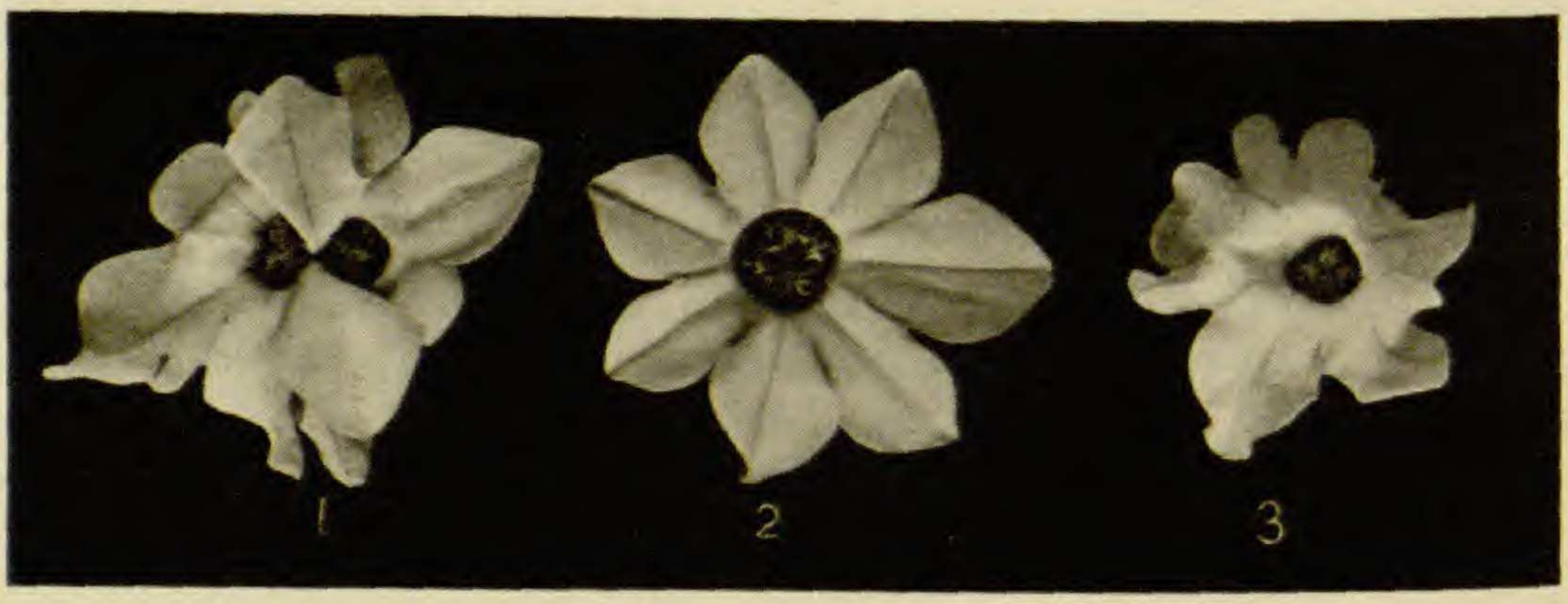

FIG. 2.—Views of abnormal blossoms *1*, *2*, and *3*, looking into throat.—T. 1559

trifle longer and flatter than in the normal blossom, and showed also a double-anther structure. The remaining 7 filaments and anthers appeared normal in all respects. Although this blossom possessed one corolla tube, which was somewhat larger than in the normal blossom, the ovaries and pistils remained distinct, as in blossom

no. 1. The petals were 7 in number, and the calyx possessed 7 sepals.

ABNORMALITY NO. 3.—In this instance the double-blossom structure has affected not only the corolla, but also the ovaries, pistils, and stamens, producing complete fasciation. In size, shape, appearance, and number of petals, the corolla and corolla tube are identical with blossom no. 2. The corolla possessed 7 lobes, and the calyx, similar in all respects to no. 2, possessed 7 sepals. Apparently only 7 stamens are present. One of these unmistakably

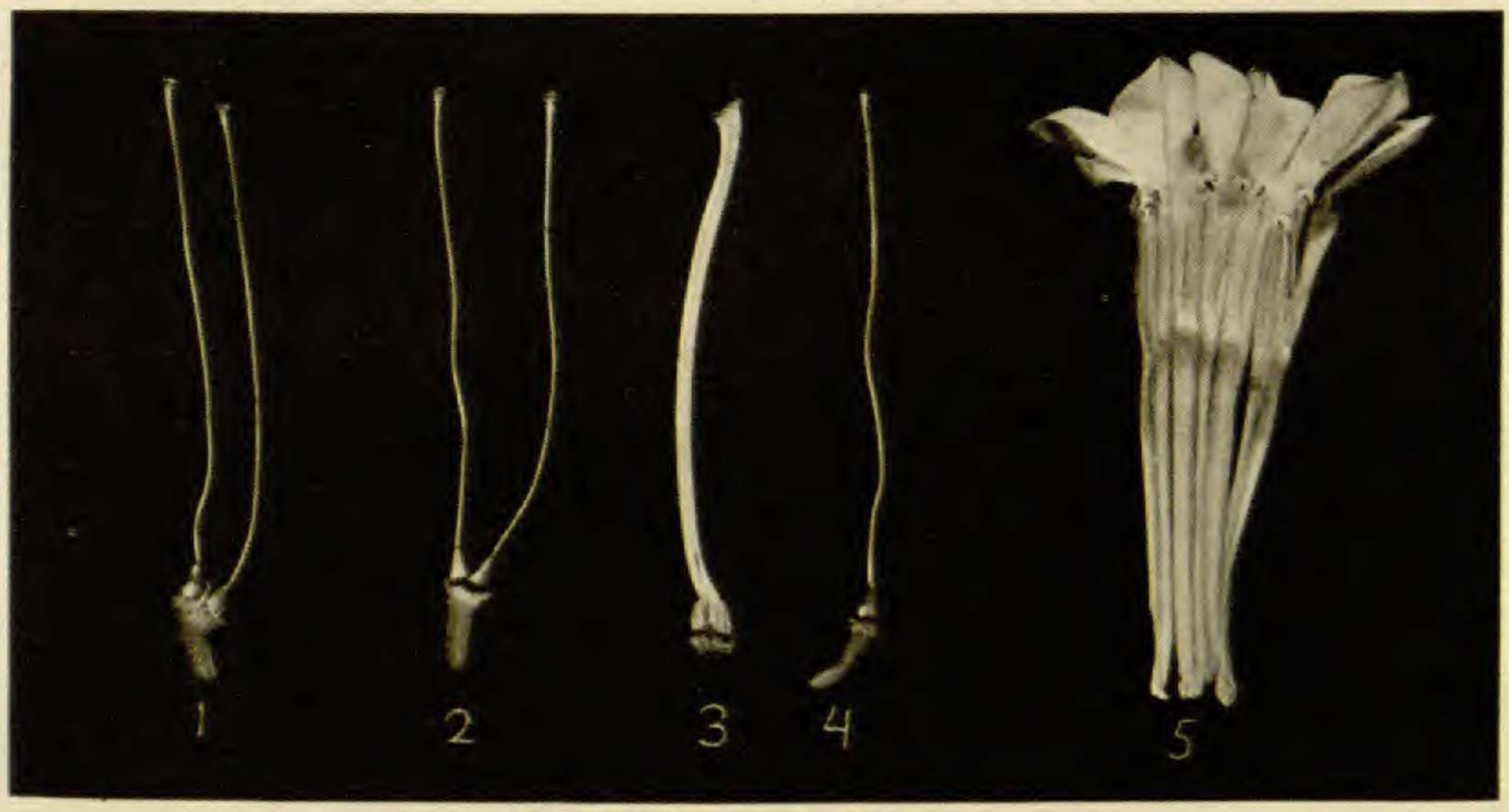

Fig. 3.—Corollas of abnormal blossoms *1*, *2*, and *3* removed, showing ovary and pistil structures; *4*, ovary and pistil of normal blossom; *5*, opened corolla of *3*, showing fasciation of pistils and ovary.—T. 1561.

has a double-anther structure. There is some indication of a third anther sac, although this cannot definitely be determined from observation. The filament of this structure was very broad and much flattened throughout. The pistil structure showed a broad, double stigmatic surface, and a broad, much flattened style leading down to a double ovary structure. Although the ovaries were united, each ovary appeared to possess its own walls. In other words, the ovary structure appeared as two closely appressed single ovaries.

ABNORMALITY NO. 4.—In this instance three blossoms are involved in the coalescence (fig. 4). The two blossoms at the right

have a common corolla tube which incloses two separate ovaries, each with its own pistil, as in abnormality no. 2. In this blossom 9 filaments and anthers were also present. The blossom at the left was normal in all respects, except that the corolla tube throughout its length was united with the double corolla tube structure at the right, but did not communicate by an opening at any point. A common calyx possessing many sepal-like divisions inclosed these blossoms. This peculiar blossom formation represents virtually a combination between abnormalities no. 1 and 2.

FIG. 4.—Fasciation involving 3 blossoms; union of 2 blossoms at left with common corolla tube inclosing 2 separate ovaries; at right single normal blossom with corolla tube united throughout to double corolla tube structure at left.—T. 1562.

In other plants grown from the same lot of seed, various examples of similar abnormalities in the blossoms have appeared from time to time. In one instance a double-blossom structure appeared as in abnormality no. 2, except that the common corolla possessed 9 instead of 7 lobes; 9 stamens were also present. In other instances showing similar doubling of the blossoms, 11 distinct stamens and 11 distinct corolla lobes were present. Experiments have shown that these abnormalities are more or less hereditary, and, for that reason, the predisposing cause is associated with the germ plasm.

Catacorolla in blossoms of Nicotiana Tabacum as a result of mosaic disease

The blossom abnormality known as catacorolla has received considerable treatment in the literature bearing on teratological phenomena. Catacorolla has been noted in plants of many families. Among the Solanaceae various species of *Nicotiana* have shown instances of catacorolla. PENZIG[3] described and figured

[3] PENZIG, O., Miscellanea Teratologica. Mem. del Reale Instituto Lombardo, **15**:147–212. 1884.

instances of catacorolla in *N. Tabacum*, but did not determine its relation to the inherited organization of the plants.

WHITE[4] describes rather fully and illustrates the abnormalities of petalody, pistillody, and catacorolla in certain species of *Nicotiana*. He gives an interesting discussion of the occurrence of catacorolla in F_2 plants of the cross *N. Langsdorfii* and *N. alata*, the parents of which were normal. WHITE found that the type of catacorolla

FIG. 5.—Various phases of catacorolla in *N. Tabacum* produced by mosaic disease; limb of corolla in most instances has undergone excessive development, greatly increasing circumference; although structures simulate doubling in appearance, corolla structure alone is involved, and doubling is only apparent; in fifth blossom (upper row) a very beautiful ascidium or pitcher-like structure is shown.—T. 1704.

with which he worked was hereditary, and in crosses with normal plants it was found to be more or less intermediate in its expression.

Blossom abnormalities associated with fasciation have also been described and illustrated. Some of these resemble very closely certain phases of catacorolla. WHITE[5] describes fasciation

[4] WHITE, O. E., Studies of teratological phenomena in their relation to evolution and the problems of heredity. Amer. Jour. Bot. 1:23–36. 1914.

[5] WHITE, O. E., The bearing of teratological development in *Nicotiana* on theories of heredity. Amer. Nat. 47:no. 565. 1913.

which occurred in Cuban tobacco grown in Cuba. PAOLINI[6] describes and gives an excellent illustration of fasciation occurring in the variety Samsum (*N. Tabacum*), grown in Asia Minor. This is evidently another instance of extreme fasciation similar to that which appeared in the Cuban variety in Cuba. SCARPUZZA[7] described and illustrated fasciation similar to that observed by PAOLINI.

FIG. 6.—Catacorolla in *N. Tabacum* produced by mosaic disease; in most instances development has been suppressed in these blossoms; ascidia shown in third and fifth blossoms (upper row); last blossom in lower row shows tendency toward fasciation; 2 blossoms, one nearly normal, another abnormal, are inclosed in common calyx.—T. 1576.

During the writer's investigations of the mosaic disease of tobacco, catacorolla has been one of the most common abnormalities produced in the blossoms of *N. Tabacum* in connection with the

[6] PAOLINI, V., Caso di Concrescenza in una Pianta di Samsum. Boll. Tecnico del R. Instituto Sperimentale in Scafati (Salerno). **6**:no. 4. 1907.

[7] SCARPUZZA, A., Di Alcune Anomalie Morfologiche su Piante di Aya Solouc. Boll. Tecnico del R. Instituto Sperimentale in Scafati (Salerno), anno VI, no. 4; July–August, 1907.

disease. All phases of catacorolla have been noted. Very frequently the normal development of the corolla has been considerably exceeded, producing large and very showy blossoms, with a much folded and greatly increased circumference or border (fig. 5).

Although the tobacco blossom is normally gamopetalous, the parts of the corolla may be more or less completely separated by clefts into petaloid segments. In some instances these have been replaced by very striking and beautiful ascidia or pitchers, borne

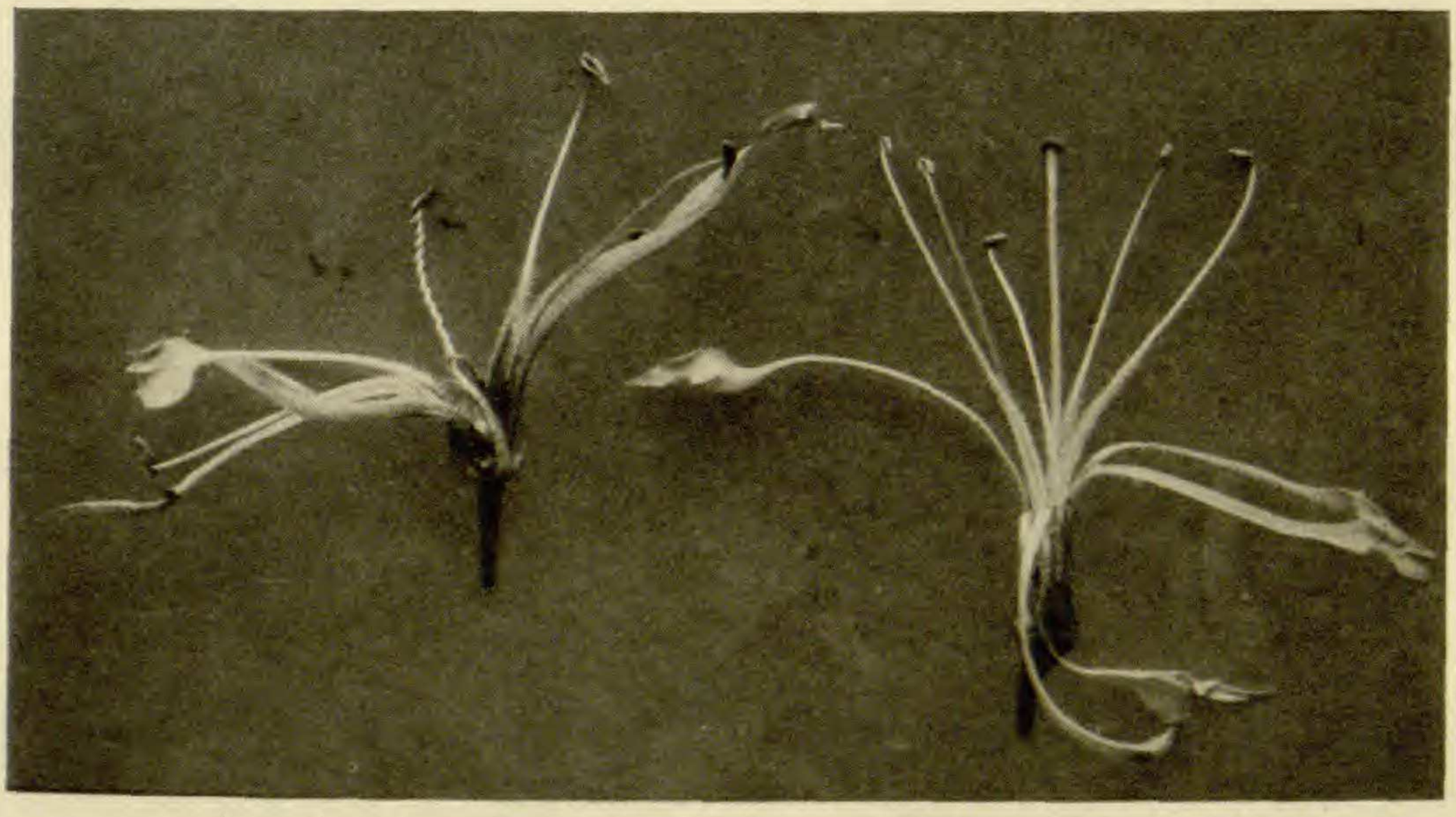

FIG. 7.—Abnormal blossoms of *N. Tabacum* produced by mosaic disease of tobacco; corolla development has been almost completely suppressed; in blossom at left pistil shows peculiar twisted structure; in blossoms at right, representing the 5 corolla lobes normally present, stamens and pistils are normal in development; hairy portion of filaments in normal blossoms is adnate to corolla tube.—T. 1598.

upon long, slender, tubular stalks (see fifth blossom, top row, fig. 5, and third and fifth blossoms, top row, fig. 6). The blossom at the right in fig. 7 shows a complete separation of the corolla into 5 distinct and nearly equal petaloid segments. In this blossom the normal development of the stamens and pistils has been but little, if at all, interfered with. Although nothing is known concerning the development of the various structures of the flower in connection with the mosaic disease, it appears that disturbances in the petal primordia are more likely to occur than in the primordia of other structures.

Although the mosaic disease of tobacco may produce all phases of catacorolla in the blossoms of *N. Tabacum*, other species rarely, if ever, show this abnormality in connection with the mosaic disease. Although petunias, *Datura Stramonium*, *Nicotiana glauca*, *N. longiflora*, *N. silvestris*, *N. alata*, etc., are readily infected with the mosaic disease of tobacco, the writer has never observed the occurrence of such abnormalities in the blossoms of these plants affected with the mosaic disease.

FIG. 8.—Plant of first generation of cross Maryland Mammoth (♀)× Yellow Pryor (♂), showing development of growing points; character appeared in many plants of first generation of this cross; plant shown was grown in 8 in. pot; taller branch is 28 in. high; smaller 21 in. in height.—T. 1602.

Likewise, the blossoms of *N. glutinosa* affected with a mosaic disease similar to but not identical with the mosaic disease of tobacco have never yet shown the catacorolla abnormality. It is interesting to note, however, that first generation plants of the cross *N. Tabacum* (♀)×*N. glutinosa* (♂) show all phases of catacorolla when affected with the mosaic disease of *N. glutinosa*, to which these hybrids are susceptible. These facts indicate that catacorolla is more readily induced by the mosaic disease in blossoms of *N. Tabacum* than in many other species of *Nicotiana*.

Normal blossoms and abnormal blossoms showing all degrees of catacorolla may frequently be shown on the same branch of the inflorescence. Although the inciting cause is associated with the mosaic disease of tobacco, conditions which disturb normal growth, such as cutting back, starvation, etc., tend to accentuate the expression of the abnormality.

WHITE'S observations show that catacorolla may sometimes appear suddenly in connection with a cross and persist in the

hereditary mechanism of the tobacco plant. The writer's experiments show that catacorolla originating as a result of the mosaic disease of tobacco is not inherited. For this reason the causal factor is external or accidental in its nature, and does not extend its influence to the constitution of the germ plasm. Although it has not been definitely established that the primary cause of the mosaic diseases affecting *N. Tabacum* and *N. glutinosa* is parasitic

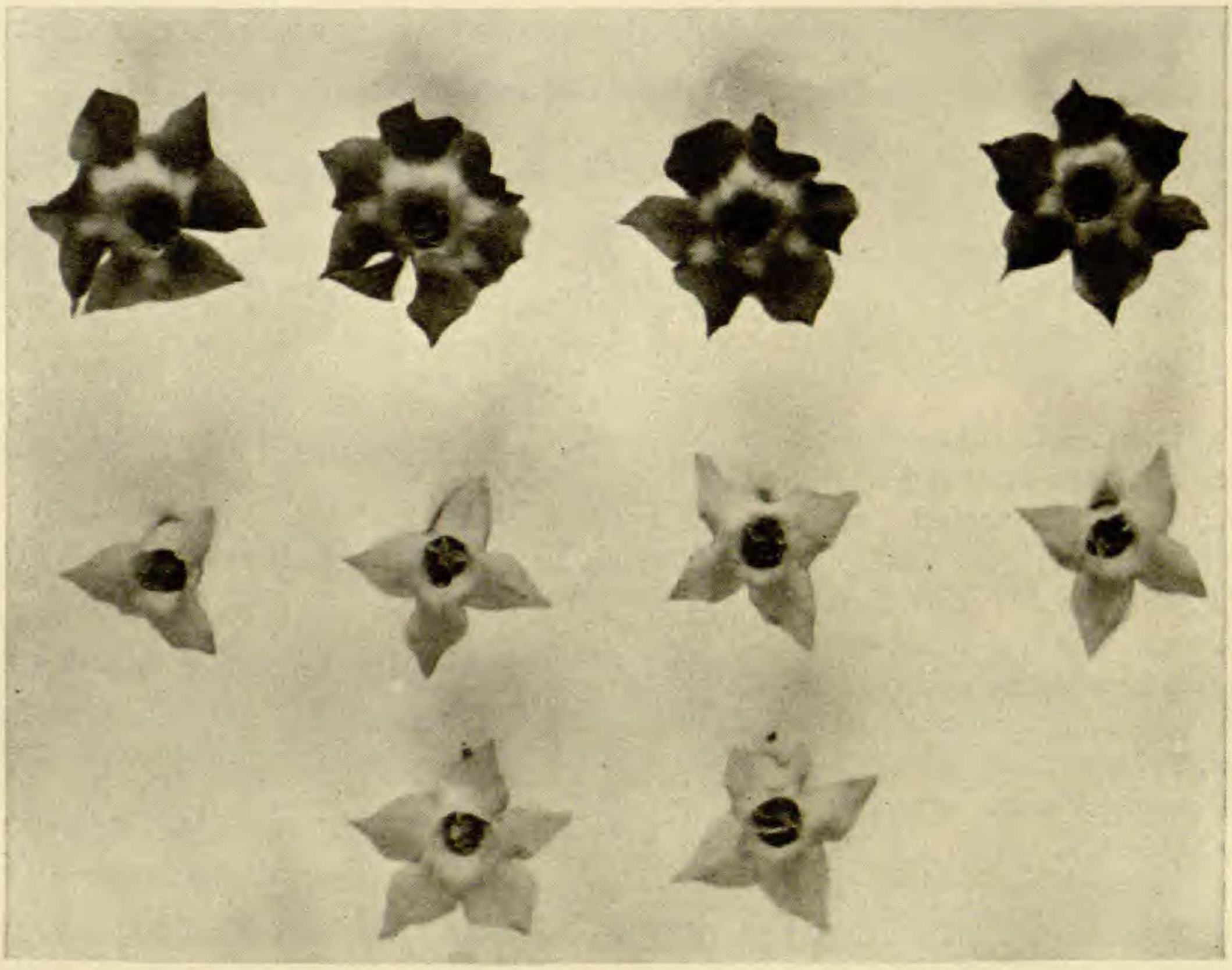

FIG. 9.—Upper row: blossoms possessing 6 and 7 corolla lobes; middle row: blossoms with 3 and 4 corolla lobes; lower row: normal 5-lobed blossom at left, abnormal blossom at right.—T. 1763.

in its nature, it is evident that the blossom abnormalities observed in *N. Tabacum* as a result of the mosaic disease are analogous in their origin to the abnormalities, monstrosities, galls, etc., due to insects, fungi, bacteria, etc.

The development of two growing points

In the cross Md. Mammoth (♀)×Yellow Pryor (♂), a number of young plants of the first generation were characterized by two

growing points (fig. 8). These were evident when the plants were very small. As the plants became older, one of the growing points was not infrequently outgrown by the stronger branch. In other instances the two growing points maintained almost equal vigor, producing two well developed stalks which finally blossomed. In the Maryland Mammoth variety there seems to be a tendency to develop bifurcation of the main stem in a small percentage of the plants. This feature, however, has usually made its appearance rather late in the development of the plant.

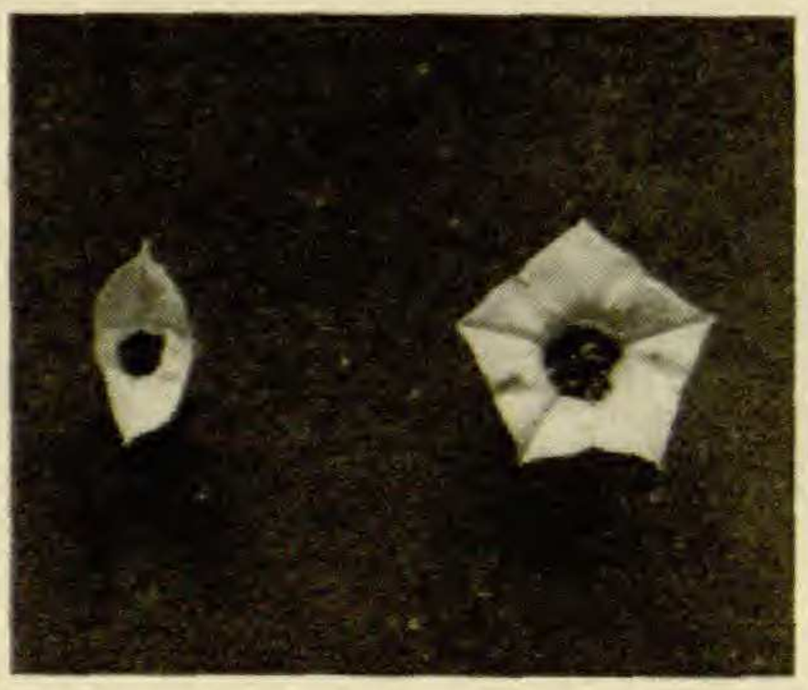

FIG. 10.—*N. Tabacum*, showing abnormal form at left, with only 2 petals; normal blossom with 5 petals from same plant shown at right; this singular blossom occurred on a plant of second generation of a cross between 2 distinct varieties of *N. Tabacum*, and was the only abnormal blossom produced by plant.—T. I. 2188.

Corolla lobes abnormal in number

In the normal tobacco blossom the corolla has 5 lobes and 5 stamens. In abnormal blossoms the number of corolla lobes may be greater or less than the normal number. Blossoms abnormal with respect to the number of corolla lobes are shown in figs. 9 and 10. The blossoms in the top row (fig. 9) were obtained from a plant of the second generation of the cross *N. Tabacum* (♀) × *N. silvestris* (♂), and were a deep red. Nearly all the blossoms produced by the plant possessed 6 or 7 corolla lobes. A few normal blossoms were produced. The plant was grown in an 8-inch pot and appeared to be normal in all respects.

The blossoms shown in fig. 9, rows 2 and 3, were obtained from a single plant of ordinary tobacco (*N. Tabacum*) and were pink in color. Although a few blossoms possessed the normal number of corolla lobes (5), the majority possessed only 3 or 4 lobes. The plant producing these blossoms showed typical symptoms of "Frenching," which appears to be a nutritional disturbance associated with unfavorable soil conditions. This plant was grown in an 8-inch pot.

An examination of the blossoms showed that the number of stamens in most instances was the same as the lobes of the corolla. The relations are given in table I.

TABLE I

Blossom no.	Row	Corolla lobes	Stamens	Result
1 (red)	Upper	7	7	Calyx and pistil normal
2 "	"	7	6	" " " "
3 "	"	6	6	" " " "
4 "	"	6	6	6 calyx lobes, pistil normal
5 (pink)	Second	3	4	Calyx and pistil normal
6 "	"	4	4	4 calyx lobes, pistil normal
7 "	"	4	4	" " " " "
8 "	"	4	4	" " " " "
9 "	Third	5	5	Blossom normal in all respects
10 "	"	4	4	Calyx and pistil normal

In blossom no. 10 a small, slender division was also evident in addition to the 4 large, equal lobes. In all the blossoms the stamens present were normal in their development.

In fig. 10 a blossom with a 2-lobed corolla is shown in comparison with a normal, 5-lobed blossom of the same plant. This 2-lobed blossom occurred on a plant of the second generation of a cross between two distinct varieties of *N. Tabacum*, and was the only abnormal blossom produced on the plant.

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